System-wide NAS

Simulation Baseline
Risk Exposure
ARC/GRC Simulation Task
September 19, 2000

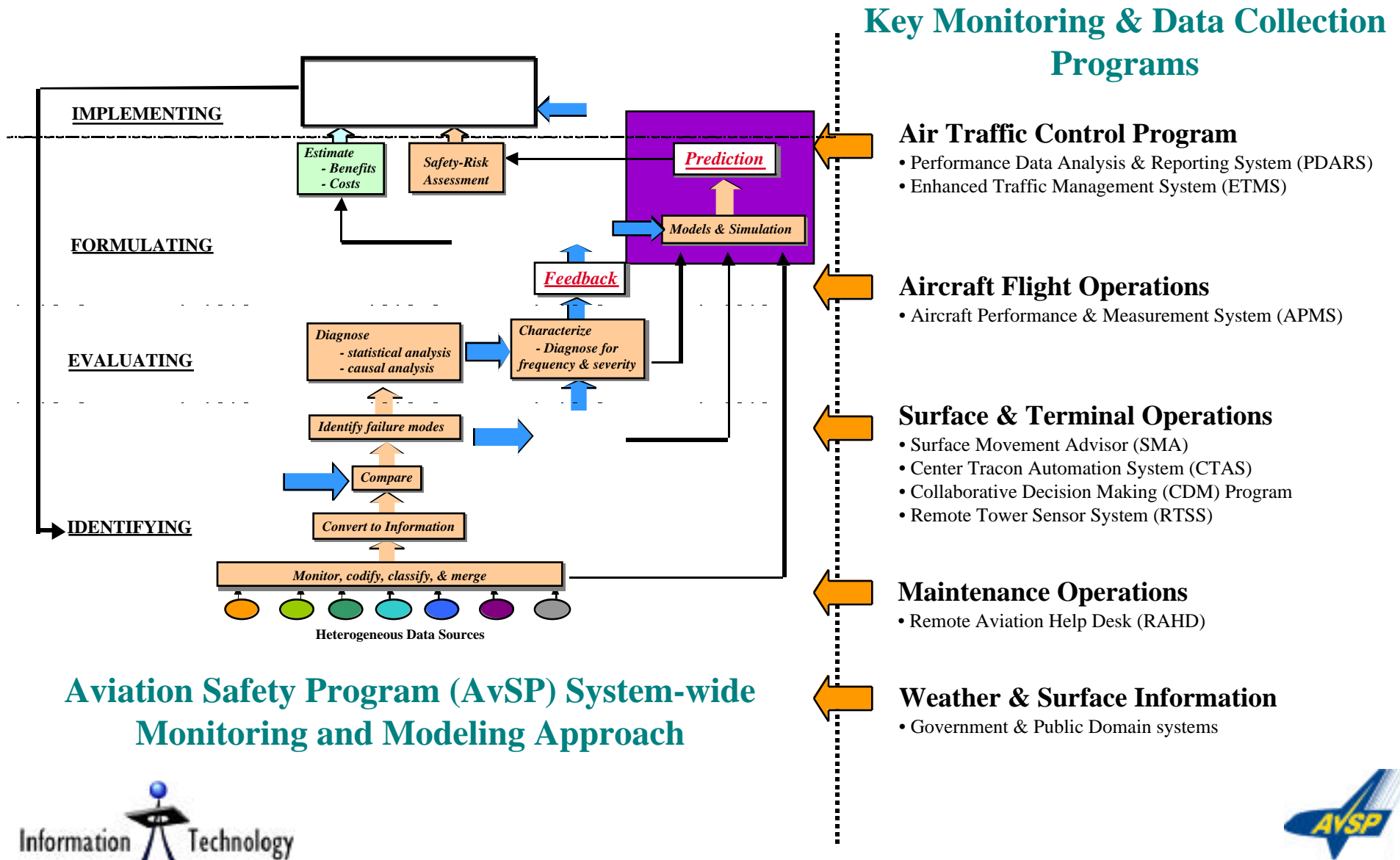**ARC Inputs from:**

Jorge Bardina: jbardina@mail.arc.nasa.gov
Yuri Gawdiak: ygawdiak@mail.arc.nasa.gov
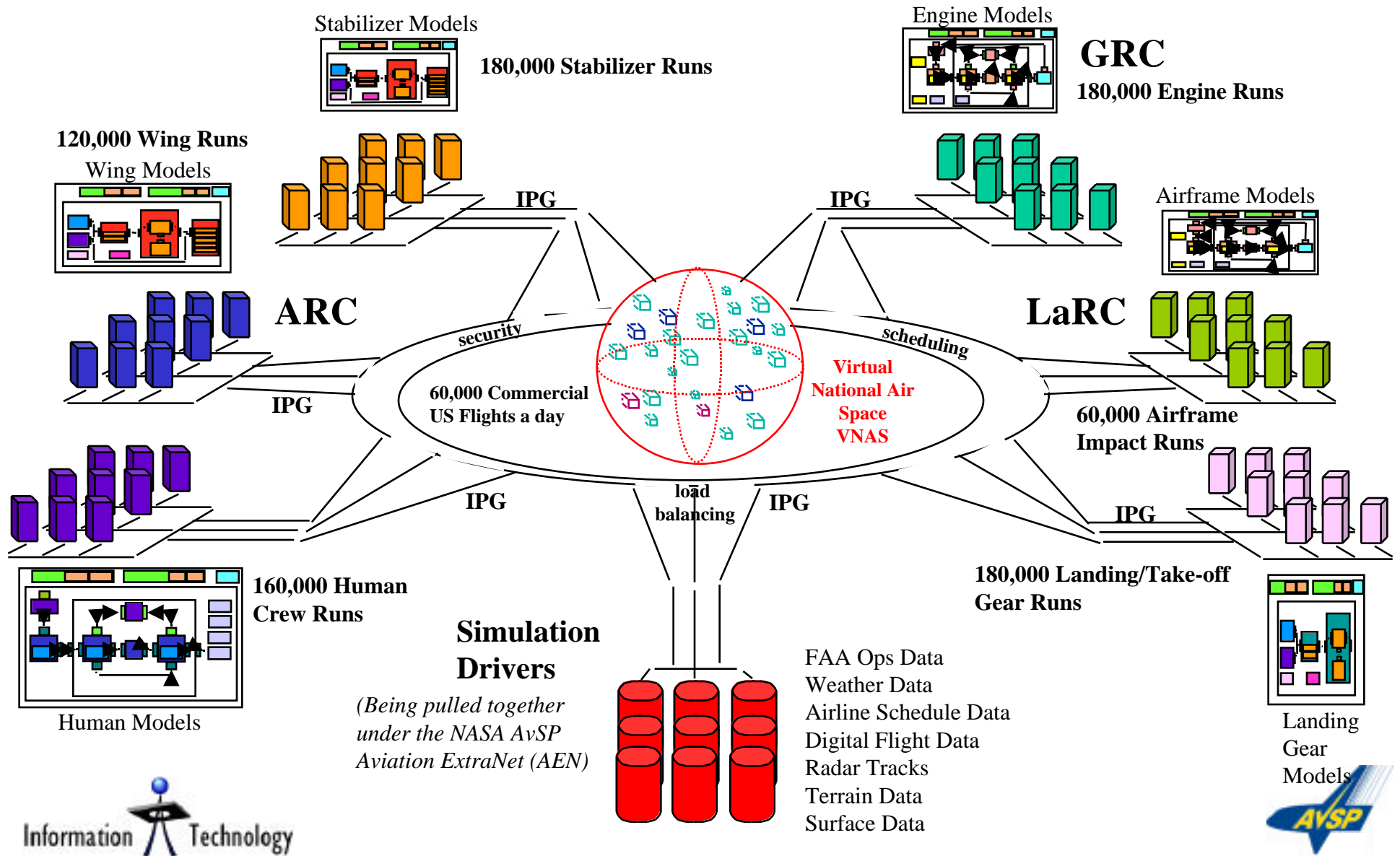**Bill McDermott**:   bmcdermott@mail.arc.nasa.gov

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System-wide Simulation Goal

Key Monitoring & Data Collection Programs

IMPLEMENTING

Estimate
- Benefits
- Costs

Safety-Risk Assessment

Prediction

FORMULATING

Models & Simulation

Feedback

EVALUATING

Diagnose
- statistical analysis
- causal analysis

Characterize
- Diagnose for frequency & severity

Identify failure modes

Compare

Convert to Information

IDENTIFYING

Monitor, codify, classify, & merge

Heterogeneous Data Sources

Air Traffic Control Program
• Performance Data Analysis & Reporting System (PDARS)
• Enhanced Traffic Management System (ETMS)

Aircraft Flight Operations
• Aircraft Performance & Measurement System (APMS)

Surface & Terminal Operations
• Surface Movement Advisor (SMA)
• Center Tracon Automation System (CTAS)
• Collaborative Decision Making (CDM) Program
• Remote Tower Sensor System (RTSS)

Maintenance Operations
• Remote Aviation Help Desk (RAHD)

Weather & Surface Information
• Government & Public Domain systems

Aviation Safety Program (AvSP) System-wide Monitoring and Modeling Approach

Information Technology

AvSP

Daily NAS Simulation
Baseline Generation

Stabilizer Models

180,000 Stabilizer Runs

Engine Models

GRC

180,000 Engine Runs

120,000 Wing Runs

Wing Models

IPG

IPG

Airframe Models

ARC

LaRC

security

scheduling

**Virtual
National Air
Space
VNAS**

IPG

**60,000 Commercial
US Flights a day**

**60,000 Airframe
Impact Runs**

IPG

IPG

load
balancing

IPG

IPG

**160,000 Human
Crew Runs**

**180,000 Landing/Take-off
Gear Runs**

**Simulation
Drivers**

Human Models

*(Being pulled together
under the NASA AvSP
Aviation ExtraNet (AEN)*

FAA Ops Data
Weather Data
Airline Schedule Data
Digital Flight Data
Radar Tracks
Terrain Data
Surface Data

Landing
Gear
Models

Information Technology

AvSP

System-wide NAS Simulation
Dimensions Of This Significant Problem

Information Coming To The GRID

 60K Flights Per day. 13K Aircraft in the air at any one time
 Radar Data From over a dozen Level V airports

 Atlanta, Boston, Chicago, LAX …

 Radar Data covering a large number of smaller airports
 Radar Data From FAA Centers for En Route segments

Simulations running at all nodes
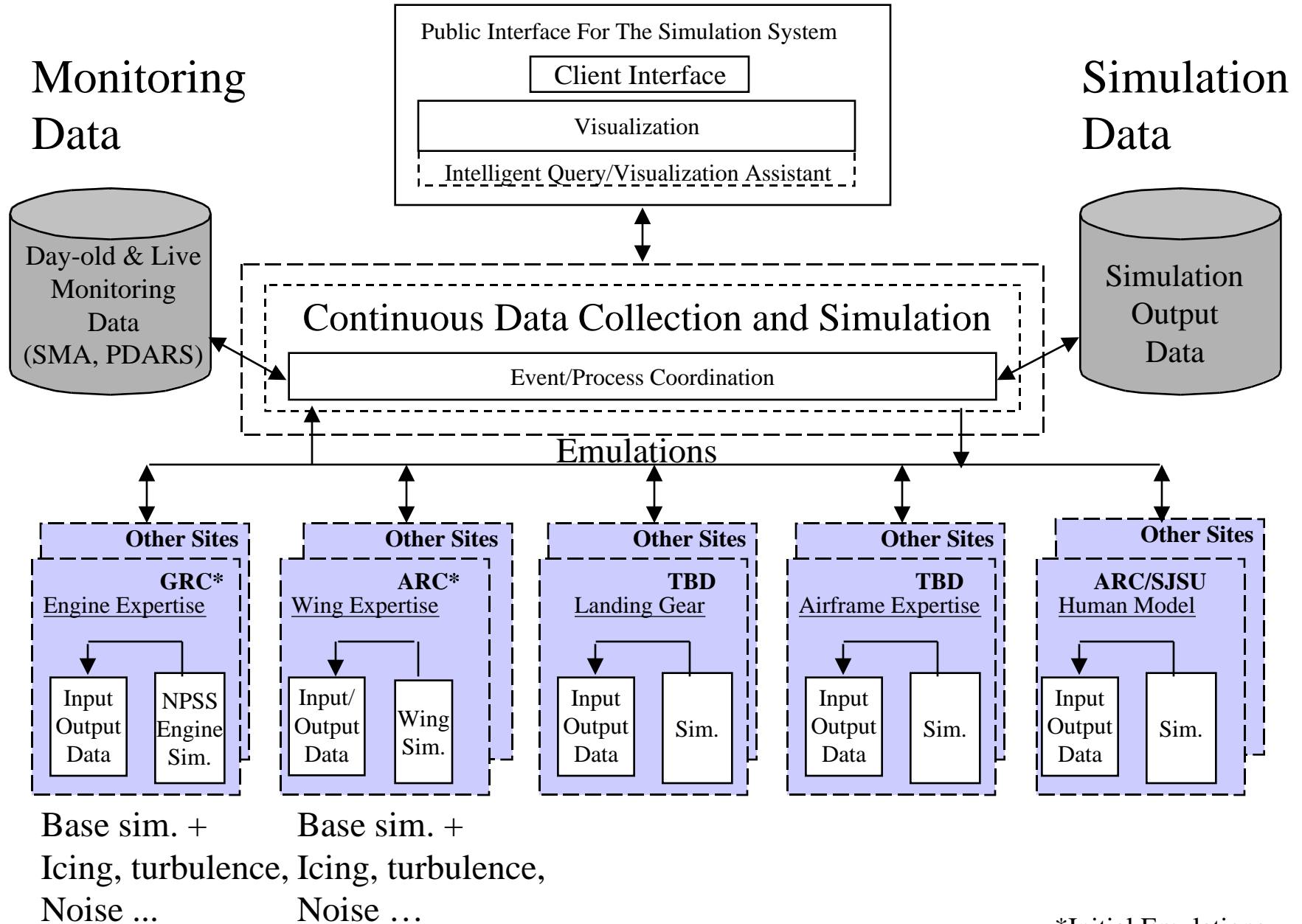
 All Models at Disparate Geographical Locations

Background tasks

 Continuous batch processing of this information for

 future data mining: FAA, Boeing, Airlines …

Information Technology

AVSP

ARC/GRC Simulation Task

- Overview of Simulation task

- Initial Simulations

- Current and Future Grid Services

Simulation Task Overview

Monitoring Data

Simulation Data

Public Interface For The Simulation System

Client Interface

Visualization

Intelligent Query/Visualization Assistant

Day-old & Live Monitoring Data (SMA, PDARS)

Simulation Output Data

Continuous Data Collection and Simulation

Event/Process Coordination

Emulations

Other Sites	Other Sites	Other Sites	Other Sites	Other Sites
GRC* Engine Expertise	**ARC*** Wing Expertise	**TBD** Landing Gear	**TBD** Airframe Expertise	**ARC/SJSU** Human Model
Input Output Data / NPSS Engine Sim.	Input/ Output Data / Wing Sim.	Input Output Data / Sim.	Input Output Data / Sim.	Input Output Data / Sim.

Base sim. + Icing, turbulence, Noise ...

Base sim. + Icing, turbulence, Noise ...

*Initial Emulations

ARC/GRC Simulation Task
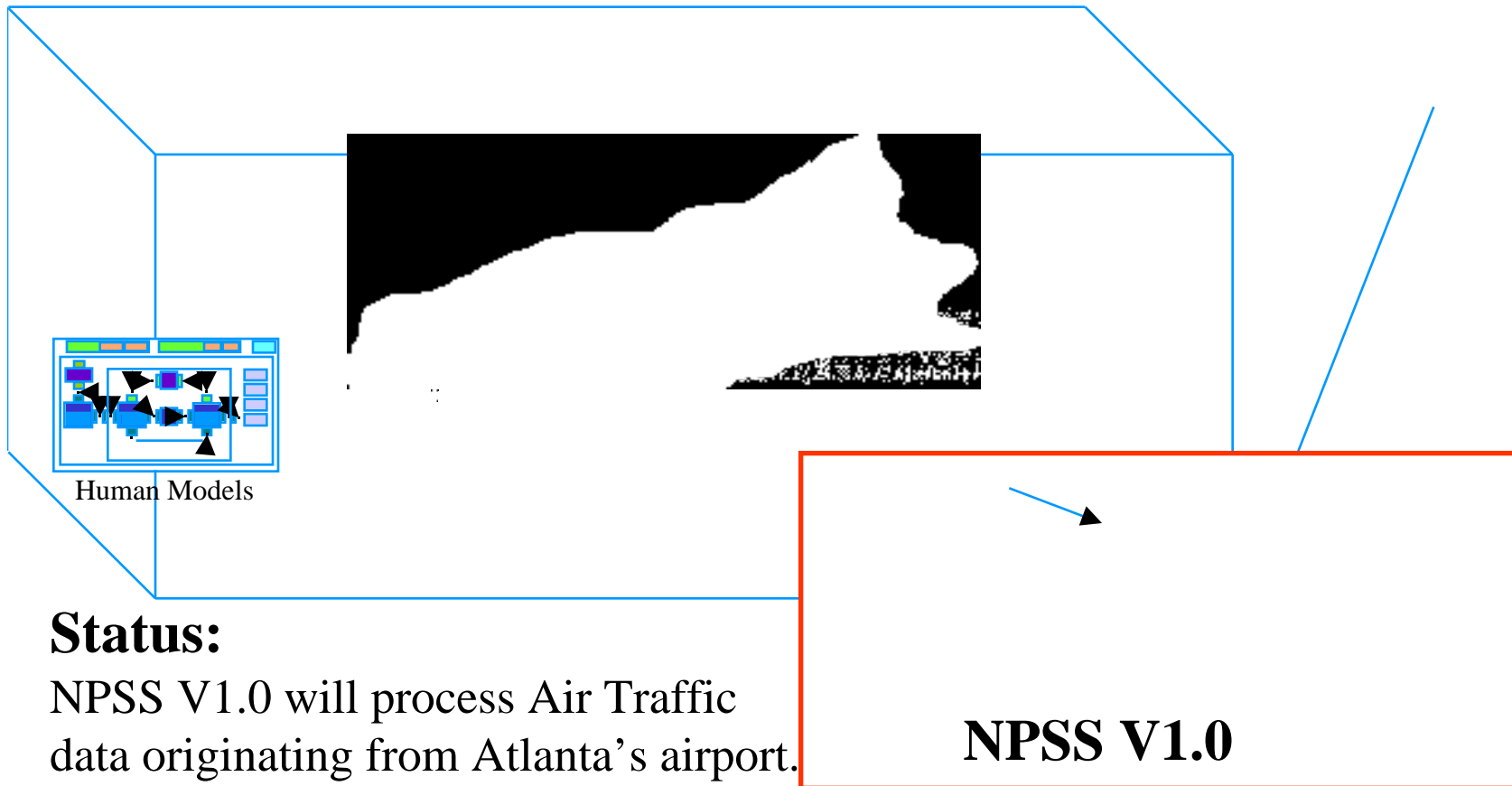# Initial Simulations

GRC: NPSS V1.0 Engine Model

ARC: Wing Model

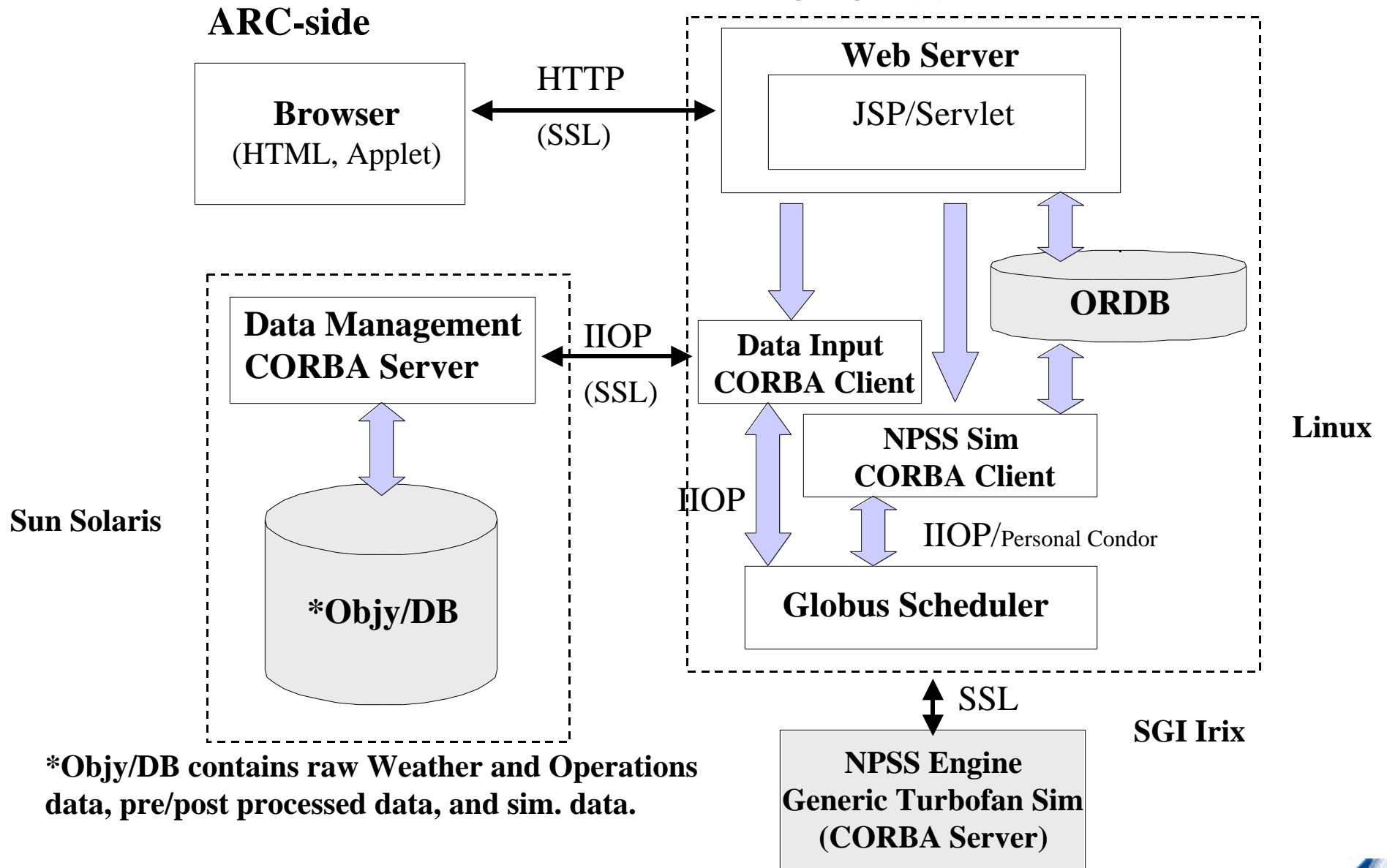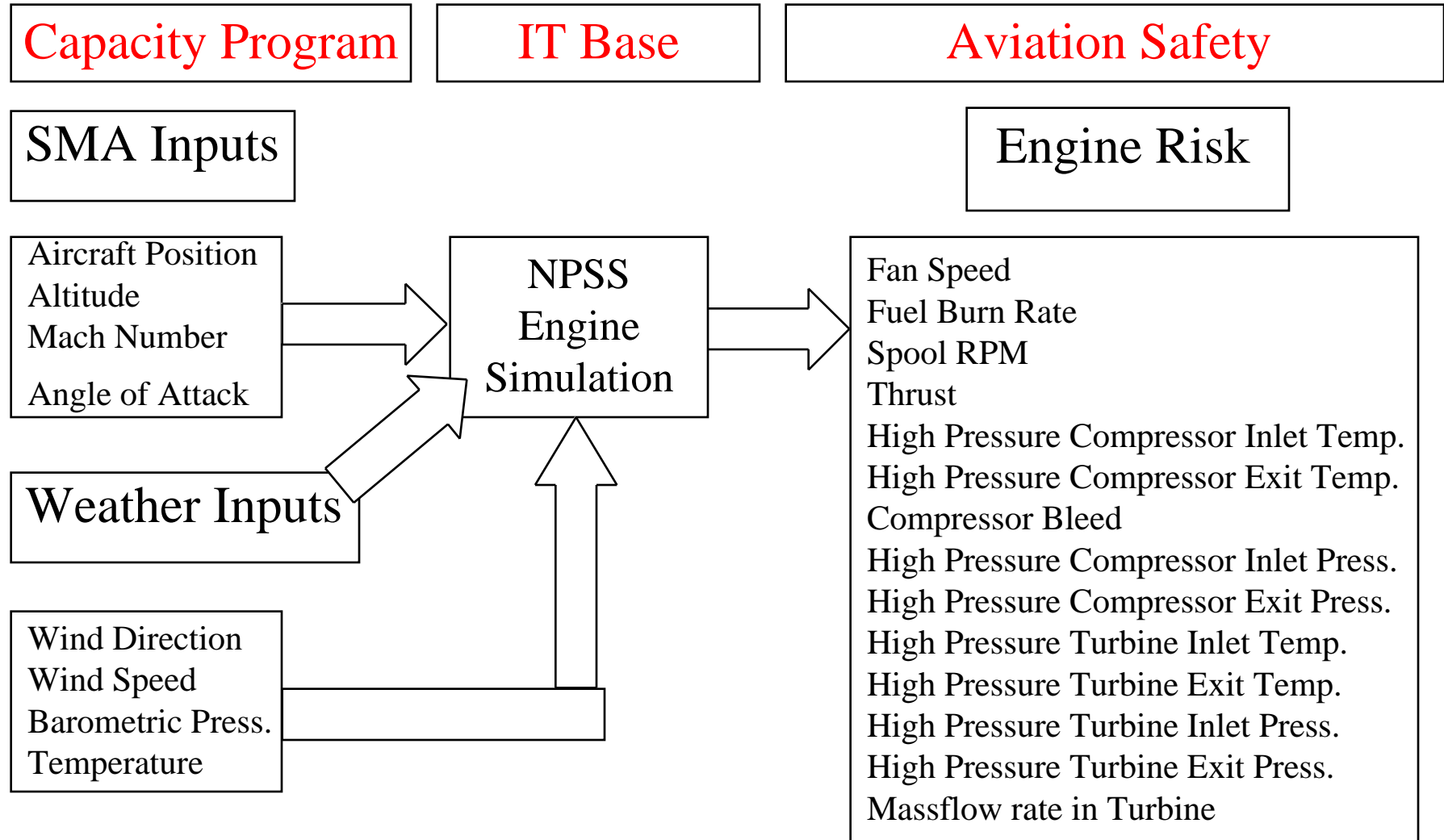# Leveraging Aviation System Monitoring and Modeling Starting FY2001

Human Models

NPSS V1.0

Status:

NPSS V1.0 will process Air Traffic
data originating from Atlanta's airport.

Interim Architecture

GRC-side

ARC-side

Browser
(HTML, Applet)

HTTP
(SSL)

Web Server

JSP/Servlet

ORDB

**Data Management
CORBA Server**

IIOP
(SSL)

**Data Input
CORBA Client**

**NPSS Sim
CORBA Client**

Linux

IIOP

IIOP/Personal Condor

Sun Solaris

*Objy/DB

Globus Scheduler

SSL

SGI Irix

**NPSS Engine
Generic Turbofan Sim
(CORBA Server)**

***Objy/DB contains raw Weather and Operations
data, pre/post processed data, and sim. data.**

Information Technology

AVSP

Engine Model

**NAS Simulation Baseline
Risk Exposure Concept**

- **Objective/ Output:**   Baseline and Track Risk Exposure of Engines
                                        on Commercial Airliners;

- **Associated Program Sponsor:**   SMA
- **Target Customers:**   FAA, Commercial Airlines
- **Type Of Model/Sim:**   NASA Software
- **Owner of Model/Sim:**   NASA
- **Development Partners:**   GRC
- **Significant Features/Sub-element:** Real-time engine risk-exposure
- **Future Milestones and deliverables:** Engine stresses; Environmental Exposure;
                                        Efficiency;
                                        Graphical User Interface Overview Systems
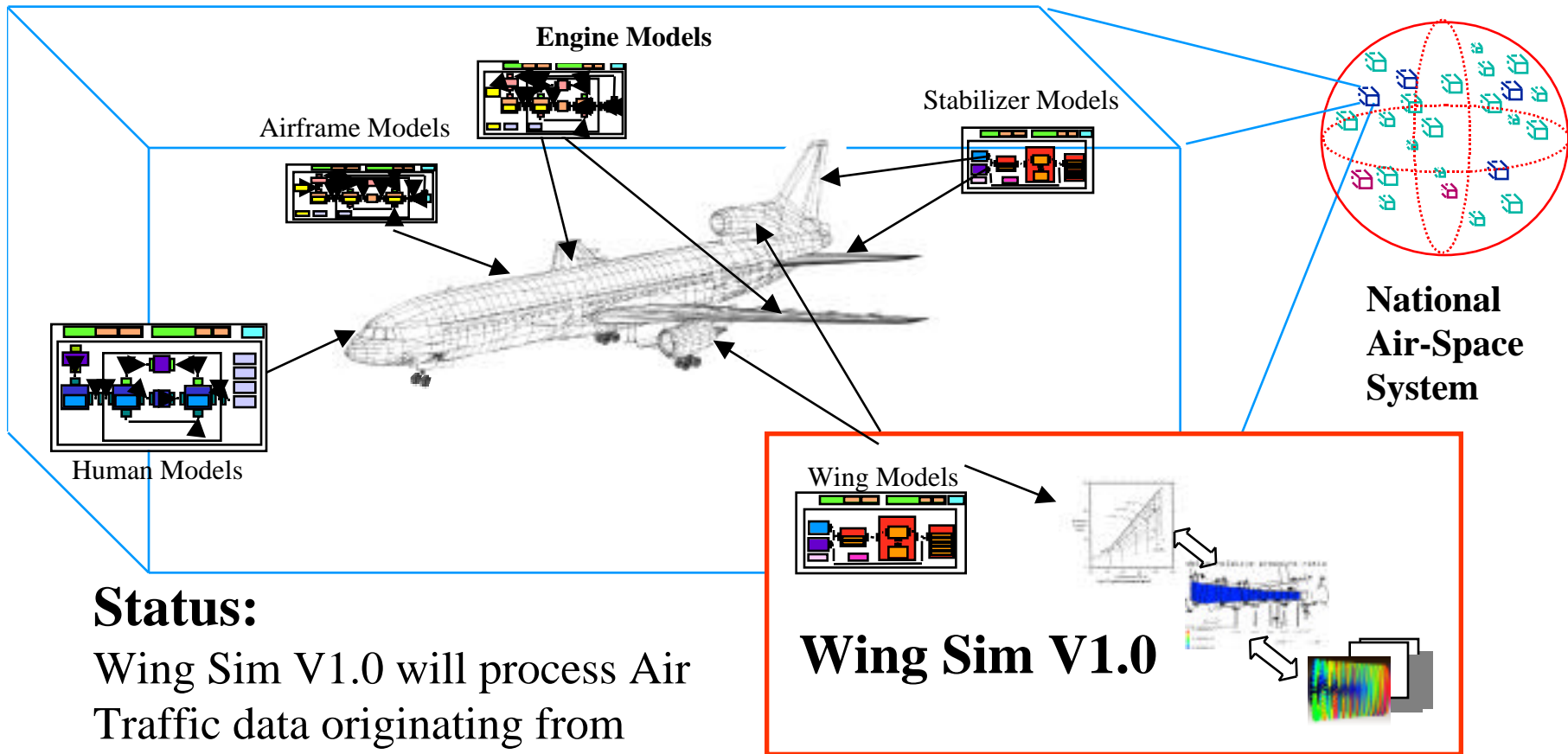- **POC:**   Greg Follen, W. McDermott

Information Technology

AVSP

Engine Expertise
Input Data and Sim. Output Data to be Sent to Simulation System

Capacity Program	IT Base	Aviation Safety

SMA Inputs

Engine Risk

Aircraft Position
Altitude
Mach Number

Angle of Attack

NPSS Engine Simulation

Fan Speed
Fuel Burn Rate
Spool RPM
Thrust
High Pressure Compressor Inlet Temp.
High Pressure Compressor Exit Temp.
Compressor Bleed
High Pressure Compressor Inlet Press.
High Pressure Compressor Exit Press.
High Pressure Turbine Inlet Temp.
High Pressure Turbine Exit Temp.
High Pressure Turbine Inlet Press.
High Pressure Turbine Exit Press.
Massflow rate in Turbine

Weather Inputs

Wind Direction
Wind Speed
Barometric Press.
Temperature

Information Technology

AVSP

Aviation System Monitoring and Modeling Starting FY2001

Engine Models

Airframe Models

Stabilizer Models

Human Models

National Air-Space System

Wing Models

Wing Sim V1.0

Status:
Wing Sim V1.0 will process Air Traffic data originating from Atlanta's airport.

Information Technology

Wing Model

- **Objective/ Output:** Early warning of failure modes, fatigue, life expectancy.
- **Associated Program Sponsor:** SMA, Virtual Flight
- **Target Customers:** FAA, Commercial Airlines, Boeing
- **Type Of Model/Sim:** NASA Software
- **Owner of Model/Sim:** NASA
- **Development Partners:** (LaRC, Boeing)
- **Significant Features/Sub-elements:** Real-time Aerodynamic Coefficients
- **Future Milestones and deliverables:** Wing components: Leading Edge, Extensible Slat, De-icing Boot, Trailing Edge, Flaps, Inner Spoiler, Outer Aileron, Inner Aileron;
  System software, controls;
  Power control unit (hydraulics, actuators);
  Graphical User Interface overviews systems
- **POC:** J. Bardina, W. McDermott

Information Technology

Wing Expertise
Input Data and Sim. Output Data to be Sent to Simulation System

Capacity Program

IT Base

Aviation Safety

SMA Inputs

Design

Wing Risk

Aircraft Position
Altitude
Mach Number

Angle of Attack

Wing Simulation

Weather Inputs

Wind Direction
Wind Speed
Barometric Press.
Temperature

Lift, Drag, Side-force Coefficient
Pitching Moment, Rolling Moment,
Yawing Moment Coefficients
Lift, Drag, Yaw Forces
Pitching, Rolling, Yawing Moments
Aileron Area and Angle
Elevator Area and Angle
Flap Area and Angle
Stabilizer Area and Angle
Spoiler Area and Angle
Tab Area and Angle
Tail Area
Rudder Area and Angle
Wing Area and Span
Wing Mean Chord

Information Technology

AVSP

Current and Future GRID Services

Computational Resources

    Multiple processors

Secure Communications

    Interconnecting Centers and other research organizations, Government agencies

Capability to handle disparate work-load

    Discrete manual submission to large number of automated/batch submissions

And all the issues related to the above requirements

Information Technology

AVSP

Current and Future GRID Services

Timeframes Needed For:

      Near term Upon Request Wing Simulation

      Near term Upon Request Engine Simulation

      Near term Batch Simulation both Engine & Wing Sim

      Automated Daily Batch Engine and Wing Simulation of Entire Day's Flights

Understand how to automate routine submission of large number of batch jobs.

Understand Process for Using the system

Current and Future GRID Services

Requirements

Near term Upon Request Wing Simulation
  Atlanta Input Data (30 -- 40 Mbytes)
  Sim. Output Data (30 -- 40 Mbytes)

Near term Upon Request Engine Simulation
  Atlanta Input Data (30 -- 40 Mbytes)
  Sim. Output Data (30 -- 40 Mbytes)

Near term Batch Simulation both Engine & Wing Sim.
  One Entire Day's Flights (2300)
  Atlanta Input Data (60 Mbytes/day)
    2300 flights/day (parallel simulations)
     300 records per flight
  Every Sim/Model Output Data (60 Mbytes/day)

Automated Daily Batch Engine and Wing Simulation of Entire Day